

Remarks/Arguments

This paper is filed in response to the Office Action of May 2, 2008. In the Office Action, the Examiner rejected all claims 17-30. For the following reasons, reconsideration is respectfully requested.

Section 112, 2nd paragraph, rejections:

Claims 17-30 were rejected under 35 U.S.C. § 112, 2nd paragraph, as being indefinite. According to the Examiner, claim 1 [17] recites a step for extracting oxygenates in a liquid-liquid extraction, but that the claim does not include a step of contacting the hydrocarbon stream with the solvent. According to the Examiner, it is unclear whether the oxygenate is extracted from the hydrocarbon stream or another stream. Claim 18 was rejected as including insufficient antecedent basis for the limitation "the aqueous phase of a bottoms product".

In response, independent claim 17 has been amended as provided above. As amended, claim 17 now recites the step of contacting the solvent with a hydrocarbon stream. In addition, the amended claim language states that the oxygenates are extracted from the hydrocarbon stream. Claims 18-30 depend, directly or indirectly, from independent claim 17. Accordingly, it is believed that the amendment to claim 17 also overcomes the rejections of dependent claims 18-30.

In addition to the foregoing, claims 18-20 have been amended to make them consistent with amended claim 17, and to address the rejection of claim 18 for lack of antecedent basis.

Section 103(a) rejections:

Claims 17-30 were rejected under 35 USC §103(a) as being unpatentable over Becker et al (DE 199 11910 A1) alone or in view of De Wet et al (WO 02/31085 A2).

As amended, independent claim 17 is directed to a process for extracting oxygenates from a hydrocarbon stream containing a range of hydrocarbons in the C₈ to C₁₆ range. The process includes a liquid-liquid extraction step of contacting

the hydrocarbon stream with a solvent comprising a mixture of methanol and water to extract the oxygenates from the hydrocarbon stream. An extract from the liquid-liquid extraction step is sent to a solvent recovery column from which a tops product comprising methanol, olefins and paraffins is recycled to the liquid-liquid extraction step, thereby enhancing the overall recovery of olefins and paraffins.

Becker et al discloses a process for removing oxygenates from a C₈ hydrocarbon stream using liquid/liquid extraction. The solvent is chosen from water and an alcohol selected from methanol, ethanol, propanol or butanol. All of these solvents form azeotropes with C₈ hydrocarbons, and not with the relevant oxygenates. In this case, the azeotrope of the solvent with the hydrocarbon is lighter boiling than either of the pure components (solvent or hydrocarbon). This means that the solvent/hydrocarbon azeotrope can therefore be distilled overhead without carrying the oxygenates (from the same boiling range as the hydrocarbon) overhead.

In the present invention, the extraction process is for a hydrocarbon stream that contains a range of hydrocarbons in a C₈-C₁₆ range. This range of hydrocarbons prepared by distillation would have various oxygenate and hydrocarbon species of varying carbon number range. The boiling points of certain hydrocarbon species in such a cut would therefore overlap with certain oxygenate species. For example, the boiling point of C₁₀ hydrocarbons would generally overlap that of C₈ alcohols.

Claim 17 of the present application recites the recycle of the tops from the solvent recovery column comprising methanol, olefins and paraffins to the extraction step. Becker et al does not teach or suggest this feature. This recycle process constitutes a differentiating feature of the present invention over Becker et al, and furthermore, is an aspect of the invention which leads to the enhancement of the recovery of olefins and paraffins.

Additionally, considering the solvent recovery stage, it is known from the literature that azeotropes form between methanol and hydrocarbons up to C₉ and possibly also up to C₁₁. However, these azeotropic compositions contain a very low content amounts of hydrocarbons such as C₁₀ and C₁₁ (approximately less than 1%). This means that recovering the azeotrope allows for only limited recovery of these hydrocarbons to the overheads. In the case of the C₈ hydrocarbon/methanol

azeotrope the content of the hydrocarbon in the azeotrope is approximately 10%. This makes it possible to use this azeotrope to recover the hydrocarbon with the methanol (Becker et al).

In addition to the foregoing, the skilled person would expect that azeotropes would form between the oxygenates and hydrocarbons in the multi-carbon C_8-C_{16} cut, because of the overlap in boiling points. The expected result would be that methanol and a small quantity of the hydrocarbons would be separable as an overheads product, but the bulk of the hydrocarbons would be inseparable by distillation from the oxygenates. Surprisingly, however, it has been found that the solvent comprising methanol and water causes an extractive distillation effect. That is, it shifts the volatility of the hydrocarbons relative to the oxygenates, so that it is possible to recover significant quantities of the hydrocarbons in the overhead product.

The method of separation of the present invention is thus completely different from that of Becker et al, which relies on a favorable azeotrope between the alcohol and the hydrocarbon. By contrast, in the present invention, this azeotrope between methanol and the hydrocarbons is not responsible for the hydrocarbon recovery.

De Wet et al discloses an extraction process for separating olefins and paraffins from oxygenates in a liquid hydrocarbon stream. This reference also does not disclose recycle of the tops from the solvent recovery column comprising methanol, olefins and paraffins to the extraction step, which is an aspect of the invention which leads to the enhancement of the recovery of olefins and paraffins.

Further, in De Wet et al, the preferred solvent is a mixture of water and acetonitrile. In the summary of the invention, it is stated that the solvent could be a mixture of water and an organic liquid such as n-propanol. This reference does not disclose a solvent that is a mixture of water and methanol. If the present invention were carried out with a mixture of propanol and water, because of the lower polarity of propanol, propofol will form azeotropes and oxygenates will be taken overhead in the solvent recovery column. As a result, the benefit of the present invention would not be attained.

In addition to the foregoing, as discussed at page 9, lines 9 to 15 of the present specification, normally a high-boiling solvent is preferred in liquid-liquid extraction because solvent recovery steps require less energy than would be the case for a low-boiling point solvent. The inventors have, however, surprisingly, found that a mixture of methanol and water (which is a low-boiling solvent) can, nevertheless, be used because it can be effective at low solvent-to-feed ratios. With reference to page 9, lines 16 to 28, it is surprising that a water/methanol solvent can be used because, for a stream containing hydrocarbons in the C₈-C₁₆ range, one would not expect to be able to distill water in a solvent recovery column without azeotroping oxygenates overhead as well. According to the invention, it is possible to distill the paraffins and olefins overhead which are recycled, while recovering oxygenates as a bottoms product. The overall result is the enhancement of the recovery of olefins and paraffins.

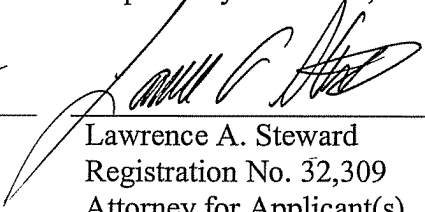
In view of the foregoing, Applicants respectfully submit that the invention as claimed in claim 17 is not unpatentable over Becker et al even if combined with De Wet et al. Claims 18-30 depend, directly or indirectly, from claim 17, and are believed patentable over the cited art for at least the same reasons that claim 17 is patentable.

Conclusion:

Based on the foregoing, Applicants respectfully submit that the grounds for rejection have been overcome, and that all claims 17-30 are in condition for allowance. Accordingly, Applicants respectfully request the issuance of a Notice of Allowance. If the Examiner believes that prosecution of this application can be advanced by way of a telephone conversation, the Examiner is invited to telephone the undersigned attorney.

Respectfully submitted,

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